$\boxed{\text{Burt Rosenberg}}$

Problem Set 2

OUT: 30 SEPTEMBER, 1997
DUE: 7 OCTOBER, 1997

Assignment

An approach to considering the necessity of a microprocessor's instruction set is to consider its minimality. That is, can instructions be removed without changing the capabilities of the microprocessor. One "proof" that a certain instruction can be removed is to show how other instructions can be combined to yeild exactly the same effect as the removed instruction.

The substituted instruction sequence might take more time, more data memory or more instruction memory than the instruction being replaced, but already the question moves from absolute necessity to measured trade-off which must be sensitive to the intended application. We can also ask whether the substitution found is the best possible, using the least time or memory, to accomplish the task, or have we overrated the instruction's importance by finding only a poor substitution.

We will investigate instruction set minimality for the Microchip PIC instruction set.

1. Is the NOP necessary? Find a one instruction replacement for the NOP.
2. The PIC gives instructions RRF and RLF for rotation through carry. How can "barrel shifting" be accomplished? For this question, you are not allowed to use SWAPF. Give code for barel shifting left and right 1 through 7 places.

   A barrel shift left moves the most significant bit (MSB) directly into the vacated position of the least significant bit (LSB). A right barrel shift moves the LSB directly into the vacated position of the MSB.
3. Is SWAPF necessary? Argue yes or give a minimal length instruction sequence which replaces SWAPF.
4. Repeat question 2 but this time you are allowed to use SWAPF. An instruction sequence of minimal length is desired for each barrel shift.
5. Are both ANDWF and IORWF necessary? Argue that they are or show why not using minimal length replacements.
6. Is CLRF necessary? Argue that it is or show why not using a minimal length replacement.
7. Is MOVWF necessary? Argue that it is or show why not using a minimal length replacement.
8. Are SUBWF and ADDWF necessary? Argue that they are or show why not using minimal length replacements, perhaps replacing one with the other.
9. Can *both* SUBWF and ADDWF be removed? Argue that at least one must be included in a miminal instruction set or give a minimal length replacement using neither for replacing either.
10. What is absolutely necessary in the PIC instruction set? Find a minimal set of instructions from which the full instruction set can be reconstructed.